

Claims

1. A swirling fluid flow expansion apparatus comprising a flared nozzle having an inlet for operative connection to a swirling fluid flow, an outlet and an intermediate
5 body having an elliptical profile with particular dimensional characteristics, said dimensional characteristics being defined by the difference in inlet and outlet radii or step height and the length of the nozzle.
2. An apparatus as claimed in Claim 1 wherein the inner profile of the nozzle
10 forms a continuous smooth curve.
3. An apparatus as claimed in Claim 1 or Claim 2, wherein the elliptical profile dimensional characteristics are calculated in accordance with a set of rules based on the inlet Swirl Number and the desired outlet (or jet) Swirl Number.
15
4. An apparatus as claimed in Claim 3, wherein a first rule determines the Area Expansion Ratio of the nozzle and, in effect, the change in Swirl Number through the nozzle.
- 20 5. An apparatus as claimed in Claim 3 or Claim 4, wherein a second rule determines the step height of the nozzle.
6. An apparatus as claimed in any one of claims 3 to 5 wherein a third rule determines the length of the nozzle.
25
7. A swirling fluid flow generator apparatus comprising an inlet duct for operative connection to a pressurised fluid source, an outlet duct coaxial with the inlet duct and an intermediate generator body comprising at least one aperture defining a fluid flow path between the inlet duct and outlet duct wherein the fluid flow path has
30 an axis orthogonal to that of the outlet duct.
8. An apparatus as claimed in claim 7 wherein the fluid flow path is defined by a plurality of apertures in the generator body.
- 35 9. An apparatus as claimed in claim 8 wherein the outlet duct is circular in cross-section and each aperture is disposed tangentially to the outlet duct.
10. An apparatus as claimed in claim 8 or claim 9 wherein four apertures are provided arranged in two axially spaced pairs; the apertures of each pair being co-planar and oppositely oriented.
40
11. An apparatus as claimed in claim 10 wherein the each pair of apertures is rotationally disposed at 90° to an adjacent pair.
- 45 12. A swirling fluid flow generator apparatus comprising an impeller mounted within a duct having an inlet and an outlet defining a fluid flow path; characterised in that the impeller includes an impeller body having a central axial longitudinal flow

blocking portion with radiating star-shaped arms; and swirling flow inducing blade elements connected to or formed with the star-shaped arms.

- 5 13. An apparatus as claimed in claim 12 wherein the impeller is formed from sheet metal.
- 10 14. An apparatus as claimed in claim 13 wherein the central axial longitudinal flow blocking portion is generally circular and defines the inner extent of the star shape.
- 15 15. An apparatus as claimed in claim 14 wherein the line formed between the impeller blade and a respective arm of the star is a tangent line.
- 15 16. An apparatus as claimed in any one of claims 12 to 15 wherein the impeller blades are inclined at an angle of 30° to 45° from the plane of the impeller; preferably about 30° .
- 20 17. A swirling fluid flow generator apparatus comprising a propeller mounted within a duct having an inlet and an outlet defining a fluid flow path; characterised in that the propeller blades are rotatable such that their pitch line changes from a radial line to a tangential line, said change causing an increase in radial flow.
- 25 18. A swirling fluid flow apparatus comprising a swirling fluid flow generator as claimed in any one of claims 7 to 17 and a swirling fluid flow expansion apparatus as claimed in any one of claims 1 to 6.
- 30 19. A combustion apparatus comprising an apparatus as claimed in any one of claims 1 to 18.
- 35 20. A seabed excavation apparatus comprising an apparatus as claimed in any one of claims 1 to 18.
- 40 21. An underwater cleaning apparatus comprising an apparatus as claimed in any one of claims 1 to 18.
- 45 22. A propulsion apparatus comprising an apparatus as claimed in any one of claims 1 to 18.
- 40 23. The use of an apparatus as claimed in any one of claims 1 to 18 in the generation of a fluid flow or jet having a Jet Swirl Number of at least about 2.
24. The use as claimed in claim 23 wherein the Jet Swirl Number is about 4.
- 45 25. The use as claimed in claim 23 or claim 24 in an combustion apparatus.
26. The use as claimed in claim 23 or claim 24 in a seabed excavation apparatus.

29

27. The use of an apparatus as claimed in any one of claims 1 to 18 in the generation of a fluid flow or jet having a Jet Swirl Number of from 0.5 to 1.0.

5 28. The use as claimed in claim 27 wherein the Jet Swirl Number is between 0.7 and 0.9.

29 The use as claimed in claim 27 or claim 28 in a propulsion apparatus.

10